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Offshore wind resource mapping combining satellite winds and mesoscale modeling

C.Hasager, M.Badger, J. Badger, F. Bingöl, M. Nielsen, I. Karagali, A. Hahmann

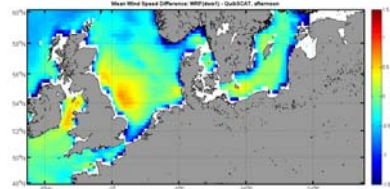
Risø DTU, Denmark

Abstract

A key challenge for mapping offshore wind resources is to obtain observations. Meteorological masts are costly and therefore sparse. Furthermore, data policy can prohibit exchange of wind information. In view of this, satellite-based wind retrieval is an alternative. The method developed by Risø DTU on using a combination of high-resolution satellite wind maps and mesoscale modeling is new. We provide a blend from the numerical wind atlas method and the observational wind atlas method. Satellites carrying Synthetic Aperture Radar (SAR) are used to map ocean winds at a spatial resolution at 1 km by 1 km grid 10 m above sea level. Thus the satellite-based results are available at higher spatial resolution than mesoscale, whereas the mesoscale has the advantage of providing results at several levels. Also satellite winds from scatterometer are compared to mesoscale model results.

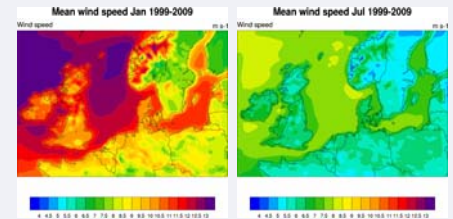
Scatterometer vs. WRF wind results

The scatterometer winds from QuikSCAT are compared to WRF mesoscale model results. Here shown the difference between WRF-QuikSCAT in the afternoon.

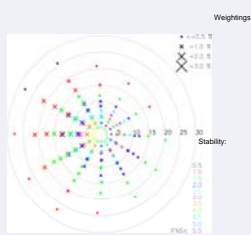
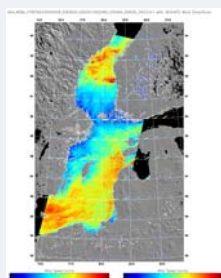


WRF vs. mast data wind results

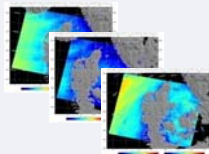
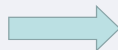
Selected scenarios are modeled by mesoscale wind resource version of the WRF model (Weather Research and Forecast Model). The maps below are from an 11-year downscaling for 1999-2009, with two domains, 45 km and a nest at 15 km. The boundary conditions are from NCAR/NCEP reanalysis II, and the increased resolution SSTs 1/4 degree.



Wind class method: SAR-based vs. mast data



Wind class definition from NCEP/NCAR re-analysis data



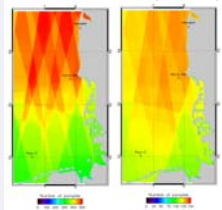
Population of each wind class with a SAR wind field

Envisat ASAR wind speed map.

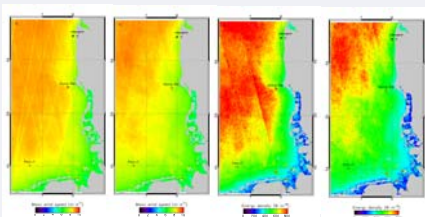
Comparing to three masts:

- FINO-1. Courtesy BMU
- Horns Rev (mast 7). Courtesy DONG Energy
- Høvsøre (using WAsP). Courtesy RISØ DTU

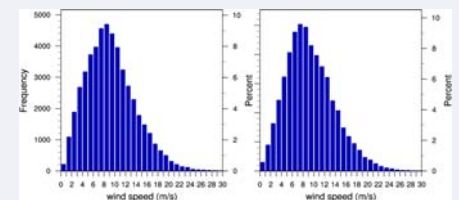
Number of wind maps (627 scenes) Wind class selection (135 classes)



Mean wind speed (627 scenes): (135 classes): Energy density (627 scenes): (135 classes):

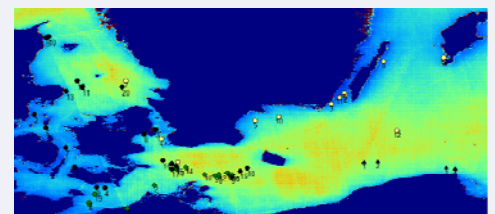


Seasonal variability.



Preliminary validation. Comparing wind speed at 100 m at Høvsøre (left) and WRF (right) in years 2004-2009.

SAR-based energy density



Energy density with existing and planned wind farms in the South Baltic Sea

Conclusions

Work in progress on satellite wind mapping and WRF wind modelling in the North Sea and Baltic Sea.

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JHU/APL: APL/NOAA ANSWRS.

